

## **SIGNIFICANT WASTE FACTORS INFLUENCING DELIVERY COST PERFORMANCE OF DESIGN AND BUILD LOW-COST HOUSING PROJECTS IN IMO STATE NIGERIA**

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### **ABSTRACT**

Effective performances particularly on Low-cost housing projects has been a major problem in many developing countries. In Nigeria, public sector clients have adopted the design and build (DB) procurement strategy as one of the strategies to deliver Low-cost housing (LcH) projects following potential benefits to facilitate improved performances particularly as it pertains to project cost. Yet, many design and build low-cost housing (DBLcH) projects are not delivered within expected target cost performances resulting from the influences of waste factors amongst several others identified. This paper aim to identify the waste factors that significantly influence poor cost performances of DBLcH projects based on the investigation of the LcH sector in Imo State Nigeria. A mixed method design, using literature review and survey questionnaire, was adopted in this study, to identify and validate contextual waste factors influencing DBLcH project cost performances. Findings revealed the significant waste factors influencing poor cost performances of DBLcH projects. This study's findings is expected to increase the awareness of the project team on the significant waste factors that will need to be mitigated towards improving the cost performances of DBLcH projects in Imo State Nigeria.

***Keywords: Cost performance, Design and build, Low-cost housing project, Waste factors***

## **1. INTRODUCTION**

Housing is described as a universally accepted second most important human need for survival and a significant factor in the productivity and worth of every individual which no government can ignore (Sheng and Mehta, 2008 cited in Lin, 2011; Un-Habitat, 2011). The rationale for consistent and adequate housing supply in many countries like Nigeria is to provide for those without homes, shelter for an ever increasing population and for the purpose of healthy and productive living amongst others (Anyanwu 1997). Low-cost housing (LcH) evolved in many countries as one of the intervention strategies by various governments to address the housing needs of the portion of the population who without assistance cannot afford adequate housing at prevailing market rates (Davis, 1997; Assaf et al., 2010). In china, LcH are classified as non-commercial housing initiated, funded and organized by state or local governments (Jingchun, 2011). Nigeria as a developing country also adopts a similar pattern but with the federal and state government responsible for the initiation, funding and organization.

LcH supply in many developing countries like Nigeria, over the years, appear to have recorded minimal success, with supply yet to meet demand and houses supplied unaffordable for target beneficiaries (Makinde 2014; Akinde, 2012; Un-Habitat, 2012). The poor LcH supply is one of the factors identified as a driver to the country's housing deficit estimated at 17 million unit (Federal Ministry of Land Housing and Urban Development (FMLHUD), 2012). This is also corroborated in the report by the coordinating Minister for the Economy of Nigeria, stating that the low production output of the housing sector currently about 100,000 units, instead of 700,000 units per year has accumulated housing deficit of about 17 million units in the country (Okonjo-Iweala 2014). Consequently, seeking viable initiatives that can improve LcH supply have become a necessity by governments at different levels to deal with the existing housing crisis in across the country.

Bridging the gap between LcH supply and demand have spurred collaborations between government housing agencies and private sector organizations in LcH project delivery. This is one of the initiative underway expected to boost LcH production and supply. The initiative has engendered the adoption of the design and build procurement strategy for LcH project delivery (FMLHUD, 2012; Gemade, 2012). The choice of adopting this procurement strategy is due to its well voiced benefits to enhance effective LcH project cost performances.

But judging by documented records from previous studies (Akinde, 2012; Olotuah & Taiwo, 2013) it is obvious that DBLcH projects most often experience poor delivery cost performances as shown in Figure 1 which have apparently impacted on market price, supply and affordability.

From Figure. 1, the trend of poor cost performances and supply can be grasped. As seen in Figure 1, the trend of poor cost performances of many DBLcH projects have been on the increase since 2003. Akinde, (2012) elucidated that the project cost performance is a significant variable impacting on both LcH production and supply. This corroborates findings by Okoroafor (2007), who argues that the performance of the project delivery costs will impact on the market prices and go a long way to determine affordability because of the relationships between project cost performances, price, and supply and demand. From these views, it suggests that the poor cost performances experienced on DBLcH projects can be regarded as a challenge apparently impacting on prevailing housing crisis situations across the country and particularly in the case of the Imo state Nigeria ( Amade et al., 2015; Obi & Arif, 2015; Ubani et al., 2013).



where £1= ₦303.00 at April, 2015 exchange rate

Figure 1. Trend cost performances of Design and Build LCH project

Source: Adapted from Akinde 2012

Imo state is one of the states in the South-East zone of Nigeria where DBLcH projects have been flagged (Gemade, 2012). Available information from the NBS, (2014) online published records show that up to 90 percent of the population in the state are below the upper middle income group. This imply pressured demand for LcH by a vast majority of populace. However, the housing situation in the state is said to be characterized by makeshift accommodations following many unsuccessful LcH supply schemes and unaffordability of available housing by many low and low-middle income groups (Duru and Anyanwu, 2014; Ozurumba, 2011; Ukiwo & Chukwuma, 2012). One would expect that this should not be the case given that Imo state was a flagship state for the pilot of the World Bank Assisted Nigerian States Urban Development Programme (NSUDP) with the major objective of setting in motion a National Low Cost Housing Programme (FMLHUD, 2012).

Investigations reveals that the housing and construction sector in Imo state is characterized by poor project cost performances which affects the effective outcome of building and housing projects in the state (Ubani et al., 2013; Obi & Arif, 2015). The ripple effects of the outcomes have apparently constrained effective LcH project delivery and impacted on supply and gone a long way to undermine affordability. Therefore, strategies towards addressing this root-cause apparently impacting on DBLcH projects likewise, can be seen as a viable step to improve future project outcomes in the state.

Several studies such as Josephson and Saukkuriipi, (2007) and Leong and Tilley (2008) investigating causes of poor cost performances on building and construction projects have identified waste as one significant factor. Withana-Gamage, (2011) attributed the occurrence of waste particularly on DBLcH projects to the influences of actions emanating from various stages of the delivery process. This view was corroborated by Akinde (2012) on a study of DBLcH project delivery in South West zone Nigeria. These actions have been identified as waste factors. Adewuyi & Odesola, (2015) argues that there are very few local studies on construction waste in Nigeria, to provide useful information for the benefit of the project team (Dania et al. 2007) towards effective project delivery. The paucity of information on the waste factors could be one of reasons constraining the project team from delivering effective project cost performances in the context of DBLcH projects in the LcH sector of Imo state Nigeria. To bridge this gap, this paper aim to identify the waste factors that significantly influence poor cost performances of DBLcH projects based on the investigation of LcH sector in Imo State Nigeria. It is expected that this study findings will contribute to existing body of knowledge on waste factor identification and increase the awareness of the project team on the significant waste factors that need to be mitigated towards improving the cost performances of DBLcH projects in Imo State Nigeria

This paper is based on findings from literature review and expert opinions and the following sections of the paper reviews extant literature on waste factors, explains the methodology adopted and discussion of findings from data analysed. Finally the paper concluded with recommendations.

## **2. LITERATURE REVIEW**

### ***2.1 Low Cost Housing***

Low-cost housing (LcH) has been defined as housing developed within adequate standard and specifications and affordable to the poor and low income group (The United Nations Human Settlements Program (UN- HABITAT), 2011; World Bank, 1975).

However, the concept of income group classification is not presumed to have a universal definition, as meaning may differ within a country, between countries and continents reflect differing national economies (Oladapo, 2001; Ogbu and Adindu, 2012). In the Nigerian context, LcH as defined in the National Housing policy document published by the Federal Ministry of Land Housing and Urban Development (FMLHUD), (2012) is housing adequately built to regulated standard and specifications and at affordable price to the low and middle incomes. It is a non-commercial housing initiated, funded and organized through federal and state governments (FMLHUD, 2012). The above definitions, suggests that specifications, standards, initiators, affordability and target beneficiaries are key terms in defining LcH. Therefore in this context LcH is defined as housing initiated, funded and organized through federal and state governments and built to regulated standard and specifications at prices deem affordable to the low and middle incomes.

The considerations in LcH supply is confined within the context of production and demand based on housing need and requirements( McNelis, 2014; Fordham et al., 1998; Tiwari, 2001;). In developing countries like china and Malaysia, LcH supply is not a profit driven venture but a vehicle and social service for meeting the shelter needs of the low and middle income population (Bakhtyar, 2013; Jingchun, 2011). Essentially, LCH supply involves series of processes by which resources such as land, labour, finance and materials are combined to produce new-build or upgrade existing housing and distribute to target beneficiaries (Agbola and Alabi 2000; Hecht, 2006). Generically, frameworks for LcH supply ( See Ball 1986 cited in McNelis 2014; Ambrose, 1991; Mostafa et al., 2006) clearly characterize the supply process into main phases which includes initiation, investment, construction, allocation and maintenance. In the Nigerian context the LcH supply emphasizes new build developments and the process as accentuated starts from the initiation through federal and state housing polices and plans, to funding and land acquisition, followed by project implementation and ends with the allocation/ marketing phase. The implementation phase involves the design and construction of the LcH project which can also be referred to as project delivery phase.

LcH projects have been described as valued, special massing housing projects aimed at constructing adequate housing within defined performance objectives of cost, time and quality for the benefit of target beneficiaries. Drawing from Kwofie et al., (2014) definition on mass housing project, LcH can be defined in this context as projects whose design and construction are standardized and constructed usually in the same or several geographical locations, executed within the same project scheme and under the same management and contract. One of the characterizing features of this LcH project delivery is the highly prioritized criterion of effective cost performances demanded by many public sector clients in like Nigeria (Oladapo, 2001; Adinyira et

al., 2012). This draws from the perceived relationship between project cost performances supply prices and demand (Okoroafor, 2007). This view has necessitated the optimization of various appropriate procurement strategies such as DB procurement strategy in the delivery of LcH projects in Nigeria.

## ***2.2 Design and Build Procurement Strategy***

Design and Build (DB) procurement strategy according to Masterman (2002) is described as an integrated system whereby a client contracts a DB organization for a lump sum, to develop full working design, obtain statutory approvals and finally construction, all as a single point of contract. This is as opposed to a traditional Design-Bid Build procurement strategy where the client appoints consultants to design and then a contractor to construct the works. The DB organization can either be appointed at the predesign stage or after the conceptual design has been undertaken (design stage) in which case, the client emphasizes to have greater influence over the initial design and specification. The DB strategy is mainly adopted in simple projects, where design quality is not critically considered as main criteria for effective delivery performance (Turner, 1990). There are variants of the DB strategy; however, they are not discussed within the scope of this paper (see Oladirin et al., 2013; Withana-Gamage, 2012). Several studies both from developed and developing country perspectives have investigated DB use in various construction projects, for example studies by Withana-Gamage, (2012), Shafik & Martin (2006) in the Scottish LcH sector, Chan, (2000); Moore and Dainty, (2001), Hale, et al., (2009) espousing potential cost benefits., and also highlight few constraints

Within the Nigerian context Idiake et al., (2015); Dada (2012) and Babatunde et al, (2010), amongst others have investigated the use of procurement strategies in Nigeria. In some cases, the cost managers, designers and construction manager form a consortium to provide integrated services corroborating similar views by Memon et al., (2014). They identified the DB strategy as one of the main strategies being employed across several building projects including LcH projects. The process on public building projects involves the DB organization engaged by the project sponsor on many occasion after the conceptual designs have been partly or completely developed by the in-house construction professionals. This is also the case in DBLcH projects as documented by Akinde, (2012). It would appear that one of the reason for this is that the housing authorities (project sponsors) want to have greater influence over the conceptual design and specification towards achieving affordable costs. Idiake, et al., (2015) and Babatunde et al., (2010) highlighted that some of the benefits of adopting the DB procurement strategy in building projects is its potential for cost and time reduction. However, they also acknowledged that effective cost performances of many DB building projects are undermined by the influences of waste factors.



This has been corroborated by Akinde, (2012) in his study of improving DBLcH project delivery in South-west Nigeria. Therefore, it has become expedient to examine and understand the concept of waste and identify the waste factors influencing the poor cost performances experienced on DBLcH project delivery process. This is further discussed in the next section of this paper.

### **2.3 Waste Factors**

Waste has been identified as one of the factors affecting construction project performance (Sibiya, et al., 2014a) and in more specific terms a significant factor impacting on a project's cost performances (Leong & Tilley, 2008; Josephson and Saukkuriipi, 2007). Koskela, (1992) and Aziz & Hafek, (2013) described waste as any inefficiency that results in the use of equipment, materials, labour, or capital in larger quantities than those considered necessary in the production of a building without creating value to the product from the point of view of the client. According to Tersine (2004) waste to include undesirable time, money and/or resources consumed in the production of the product without adding value from the perspective of the client. It can therefore be deduced and used in this context that waste is any inefficiency within the project delivery process that results in additional cost above the minimum that would have been required to deliver a housing project.

Earlier works by Ohno (1988 in Likert 2004) on the Toyota production system elucidates that waste on construction projects could be classified under two headings:

- **Process waste:** this relates to waste generated from the flow of materials. It includes defects in products, overproduction of goods not needed; inventories of goods, awaiting further processing or consumption; unnecessary processing; and unnecessary transport of goods.
- **Operations waste:** this is a labour generated waste from the by-product of unnecessary movement of people, waste of human energy and waiting by employees for process equipment to finish work.

Similarly, the works of Likert, (2004) simplified these categories into eight (8 Nr) main waste areas as shown in Figure 2.



Figure 2: Waste factors and source areas  
Source: Adapted from Likert (2004)

In Figure 2,  $\sum F1...n$  represent a summation of various actions that generates and contribute to each type of waste. These actions are referred to as waste factors (Wahab & Lawal, 2011).

Waste factors therefore are the direct or indirect actions undertaken within the project delivery process that generate and contribute to waste influencing project cost performances (Akinde, 2012; Withana-Gamage, 2012; Wahab & Lawal, 2011). Machelete (1997) categorized waste factors according to structure that is into design and construction related waste factors. This view has also been corroborated in studies by Withana-Gamage, (2011) in a study of DB building projects in United Kingdom, Wahab & Lawal (2011) and Akinde, (2012) both in a study of waste on construction projects and DBLcH project delivery respectively, in south west zone of Nigeria. In their views, design related waste factors refer to waste factors originating from the design stage while the construction related waste factors refer to the waste factors originating from the construction stage.

Consequently, Koskela (1992) argues that in meeting the primary objectives of effective project performances within the construction environment could be very challenging without identifying and addressing the factors that contribute to waste on the project from a lean thinking perspective. The application of lean thinking to the design and construction process to improve project performances in conformity to client needs and expectations is referred to as Lean construction (Koskela, 1992; Lean construction institute United Kingdom, 2015). Waste elimination is probably the single most important term in Lean Construction (Akdeniz, 2014) and the in many countries (Rahman et al., 2012; Hanna et al., 2010).



There are a variety of tools, strategies and technologies used in Lean construction such as value stream mapping (VSM), Toyota practical problem solving process and Pareto diagram to mention a few and their potential benefits to identify and map waste factors affecting building project performances are well documented across studies (Aziz & Hafez, 2013; Rahman et al., 2012; Sacks, et al., 2010).

Several studies have identified various waste factors influencing poor project cost performances across varying construction projects. For example, Osmani et al., (2008) on building and housing projects and Withana-Gamage, (2012) in the DB building projects both in the United Kingdom in developed countries. Similarly, some waste factors have been identified in studies by Nagapan, et al., (2012) in Malaysia; Muhwezi, et al., (2012) in Uganda, Polat & Ballard (2004) in Turkey, Alwi et al., (2002) in Indonesia and Ekanayake and Ofori (2000) in Singapore; Machete (1997) and Sibiya, et al., (2014b) in South Africa amongst many others have also identified contextual waste factors on building and LcH housing projects from the developing countries perspective. Many of these studies have also identified the waste factors using observational method, statistical methods and lean construction tools.

In the Nigerian building and housing sector, Adewuyi & Odesola, (2015) argues that there are very few local studies on construction waste. However, a few documented studies such as Adewuyi & Odesola (2015), Adewuyi & Otali, (2013), Akinde (2012) and Wahab & Lawal, (2011) have investigated waste factors across in building and housing projects in the south-south and south-west zone of Nigeria. Akinde (2012) specifically investigated waste factors in the context of DBLcH projects using Toyota production system practical problem-solving technique. Though the above listed studies have examined waste factors in housing projects including DBLcH projects they are not within the geographical context of the Imo state LcH sector. Therefore, this study is needful and is expected to be benefiting the project team towards improving cost performances on DBLcH projects in Imo state LcH sector. The waste factors identified from existing literature provide a platform to aid validation of the factors within this study context by expert construction professionals. The Pareto Diagram is further utilized to validate the findings.

### **3. RESEARCH METHODOLOGY**

To achieve the stated aim of the study, both primary and secondary data sourced. An exploratory sequential mixed method design was employed which allows for data collection and analysis to be carried out sequentially with the findings from the first phase informing the procedure in the second phase (Creswell 2014). In the first phase, secondary data was collected based on a review of relevant literature on waste factors and questionnaire survey allowed for the collection of primary data in the second phase.

This was designed to obtain contextual waste factors in relation to DBLcH project cost performance in Imo state Nigeria.

In the qualitative phase, exploration of relevant literature enabled proper identification of various waste factors associated with the project delivery of projects from a generic context. A search in abstracts of articles using primary key words comprising of waste, construction, building, housing and projects across Scopus and Google Scholar electronic data bases, dated between January, 2010 and December, 2014 was conducted. Ten (10 Nr) publications were purposively selected based on the comprehensiveness of the waste factors listed in the studies. Content analysis was employed which allowed for the identification of forty-three (43) waste factors from the selected publications. The findings informed the development of a 5-point Likert scale questionnaire (Tourangeau, et al., 2000).

In the quantitative phase, the sample population for the study was 36 organisations purposively drawn from a list of fully registered consultancy and contracting organisations with the State ministry and Housing Corporation based on their active involvement in DBLcH projects delivery in Imo state Nigeria. Four (4Nr) questionnaires each were distributed to the thirty six (36) organisations targeting the project managers, quantity surveyors and designers presumed to possess the requisite knowledge as it pertains to delivery cost performance of DBLcH projects based on their professional background and experience. The respondents were requested to identify the waste factors influencing poor cost performances within the context of DBLcH projects in Imo state Nigeria, categorized the waste factors based on their relationship to design and construction and rate their level of influence on the project cost performances. They were also requested to provide other waste factors relevant that were not captured in the questionnaire.

The quantitative data gathered from the questionnaires were analyzed using percentages and Weighted Average Mean Score (WMS) and presented in tables and bar charts. The decision rule adopted was that WMS between 4.5- 5 represent very high influence and 4.0- 4 represent high influence on the project cost performances. Therefore any factor with WMS within the 4.5- 5 ranges is regarded and used for further analysis employing the Pareto diagram. The Kruskal Wallis test was also conducted to determine if there were any significant differences in the perception of the different groups of respondents on the waste factors influencing poor project cost performances on DBLcH projects in Imo state Nigeria. This is to support interpretation of the findings. The data analysis and findings are presented in the following section of the paper.

#### 4. FINDINGS AND DISCUSSION

A total of 144 questionnaires were distributed to the selected 36 organisations and 85 questionnaires completed and returned were used for the analysis. A response rate of 59.03 percent was attained and the Cronbach alpha reliability test conducted on the responses yielded an acceptable co-efficient of 0.782 and therefore suitable for further analysis. The results obtained from the analysis of gathered data are presented in this section.

##### *4.1 Identification of waste factors influencing DBLcH project poor cost performances*

Table 1 and 2 shows the identified waste factors influencing DBLcH project poor cost performances by the respondents who participated in survey. The respondent based on their experiences categorized the identified factors under design and construction related waste factors corroborating classifications in earlier studies by Wahab & Lawal, (2011) and Withana-Gamage, , (2012).

**Table 1. Design stage related Contextualised Waste factors**

Waste factors	WMS	Group rank	Overall rank
Poor communication and coordination during design	4.85	1	1
Insufficient information during construction	4.75	2	3
Design changes	4.65	3	4
Inadequate project planning	4.26	4	7
Errors in quantity estimates	4.09	5	10
Unclear client brief	3.77	6	13
Poor site investigation	3.76	7	14
Poor detailing	3.63	8	15
Selection of Low quality materials	3.62	9	16
Construction technology adopted	2.10	10	31

Source: Researcher's field survey, 2014

**Table 2. Construction related waste factors**

Waste factors	WMS	Group rank	Overall rank
Poor supervision	4.80	1	2
Inappropriate material storage facilities	4.50	2	5
Poor workmanship	4.38	3	6
Delay in material delivery	4.25	4	8
Mistakes during construction	4.20	5	9
Incompetent site workers	4.05	6	11
“Opening up” for inspections	3.94	7	12
Poor communication and coordination amongst contractors work team	3.58	8	17
Inclement weather	3.53	9	18
Frequent Interference of client in house supervisory team	3.40	10	19
Inappropriate construction methods	3.23	11	20
Delay in funding	3.03	12	21
Incompetent subcontractors	2.90	13	22
Over allowances of materials	2.81	14	23
Government bureaucracy delays in statutory approvals	2.70	15	24
Poor access roads	2.64	16	25
Excess material overproduction	2.60	17	26
Community restiveness	2.57	18	27
unforeseen ground conditions	2.54	19	28
Inappropriate material delivery methods	2.50	20	29
Burglary	2.41	21	30

Source: Researcher’s field survey, 2014

It is observed from Table 1 that ten waste design related waste factors were identified by the respondents contextual to DBLcH project cost performances. based on the perceptions of the respondents, Poor communication and coordination of design team ranks 1st with a weighted average mean score of 4.85 followed by Insufficient information during construction, Design changes, Inadequate project planning and errors in quantity estimates ranking, 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup> and 5<sup>th</sup> with average mean scores of with a score of 4.75,4.65,4.26 and 4.09. The table also reveals that the least occurring waste factor is construction technology adopted with a score of 2.10.

From Table 2 it is also observed that twenty-one construction related waste factors were identified influential on DBLcH project cost performances by the respondents. Analysis based on the respondents ratings show that poor supervision ranks 1st with a weighted average mean score of 4.80, followed by inappropriate material storage facilities, Poor workmanship, Delay in material delivery, Mistakes during construction, incompetent site workers ranking 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup> 5<sup>th</sup> 6<sup>th</sup> within the group with average mean scores of 4.50, 4.38, 4.25, 4.20 and 4.05 respectively. The table also reveals that the least waste factors occurring on the projects are unforeseen ground conditions, inappropriate material delivery methods and burglary with mean scores 2.54, 2.50 and 2.41 respectively. The identified construction related waste factors from literature are also inherent in DBLcH project delivery. However, it is observed that community restiveness were peculiar within the Nigerian based literature (Adewuyi & Odesola, 2015; Adewuyi & Otali, 2013; Akinde, 2012).

From Table 1 and 2 it is observed that five (5Nr) waste factors had WMS ratings above 4.5 and are regarded to be used for further analysis using the Pareto diagram.

#### ***4.2 Prioritizing Waste Factors influencing DBLcH project cost performances using Pareto Diagram Tool***

Based on the Pareto Diagram analysis as shown in Figure 3, five (5Nr) waste factors were highly prioritized.

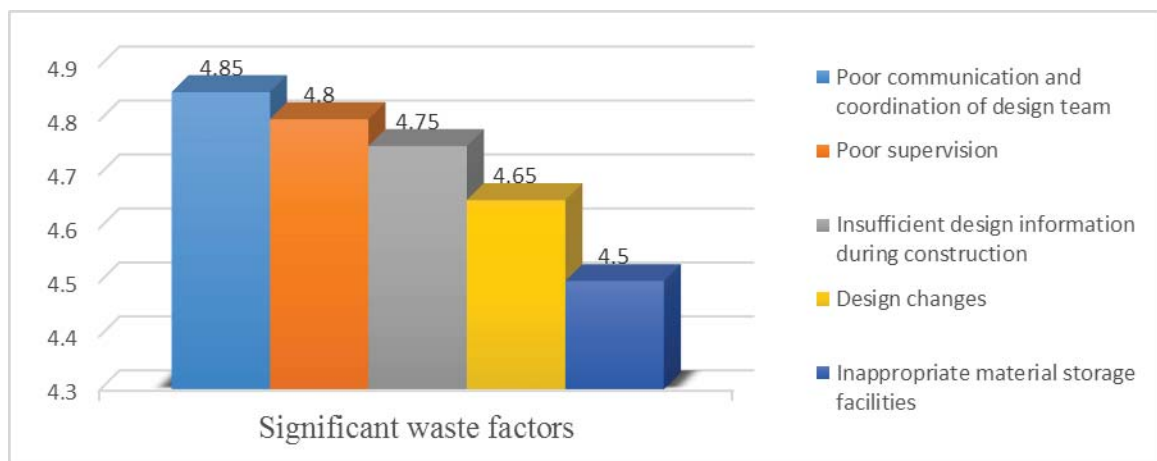


Figure3. Prioritized significant waste factors  
Source: Researcher's field survey, 2014

These factors include: poor communication and coordination of design team, poor supervision, design changes and inappropriate material storage facilities and insufficient information during construction with ratings 4.85, 4.80, 4.75, 4.65 and 4.50 respectively. Three (3Nr) of the waste factors were design related whereas the other two (2Nr) were construction related.

Further analysis based on the Pareto diagram was used to further validate the findings based on their contribution to waste generation on DBLcH projects. The results are as shown in Figure 4.

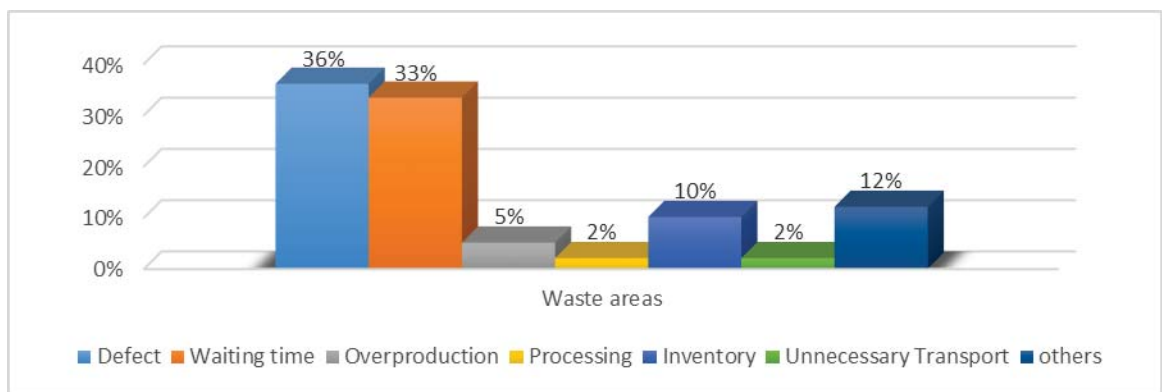


Figure.4. Distribution of Waste factors in relation to waste areas  
Source: Researcher's field survey, 2014

Based on Figure 4, respondents affirmed that the prioritized waste factors significantly contribute to seven waste areas affecting cost performances on DBLcH projects. From the analysis 36 % of the respondents confirmed that the prioritized waste factors contributed to Defects waste, 33% confirmed that the prioritized waste factors significantly to waiting time waste, 12% confirmed that the prioritized waste factors contributed to “other type of waste” 10% confirmed that the identified waste factors contributed to inventory waste, 5% confirmed that the prioritized waste factors contributed overproduction waste and 2% confirmed that the prioritized waste factors contributed to both processing and unnecessary transport.

#### **4.3 Kruskal Wallis Test of Significant Difference between Group Respondents**

This test was employed to identify if there were significant differences in the perceptions of group respondents, on the ratings of the identified waste factors influence cost performances of DBLcH projects in the Imo state LcH sector. The result from the Kruskal Wallis test carried out as shown in Table 3.



Table 3. Kruskal Wallis Test Statistics<sup>a,b</sup>

Total for Waste factors	
Chi-Square	2.000
df	2
Asymp. Sig.	.368

Source: Researcher's field survey, 2014

The result of the Kruskal Wallis Test Statistics as presented in Table 3 shows that the p-value is 0.368. This value is greater than 0.05 significant level set for the test. This implies that there is no significant difference in the overall perception of the respondents on the waste factors identified influencing DBLcH projects cost performance in Imo state Nigeria. The responses show that the project team comprised of Contractor, consultants and contractor teams who are presumed to have managerial influence on the project cost management they have same view on the various factors identified. Therefore, the study findings can be generalized for the benefit of the project team involved in DBLcH projects in the Imo state LcH sector in Nigeria.

Discussing further on the results in Tables 1 -3 and Figures 3, 4 and 5 it clearly indicate that respondents are in agreement that waste occurs on DBLcH projects and waste factors influences poor cost performances of DBLcH projects in Imo state. The findings also revealed that design related factors are highly influential waste factors on the projects. These findings corroborates previous findings by Osmani, Glass and Price (2008), Nagpan et al. (2012) Muhwezi, et al., (2012) and Adewuyi & Otali (2013) on various construction projects. The results from The results in Tables 1 -3 and Figures 3, 4 and 5 also indicated that poor communication and coordination of team during design, poor supervision, design changes, inappropriate material storage facilities and insufficient information during construction, were highly ranked and prioritized waste factors with the most significant influence on DBLcH projects poor cost performances. These waste factors are further discussed.

- Poor communication and coordination during design. Effective communication means that the information is provided in the right format, at the right time, and with the right impact. Therefore the efficient and effective coordination of the design process will depend on the quality of communication. In a case where these is lacking implies poor communication and coordination. This waste factor has been identified to lead to design errors, time loss and eventual construction failure amongst other adverse effects (Tipli, et al., 2014). According to Akinde, (2012) this waste factor is the most common cause of various types of waste in DBLcH projects and he affirms corroborations to earlier studies by Bertelsen (2004).

Therefore, various professionals in the design phase must effectively disseminate information and the project manager should effectively coordinate the team to facilitated necessary information to develop detailed drawings, specifications and elucidate construction methods (Aishawi & Underwood, 1999 cited in Olaniran, 2015). This could be achieved using appropriate formal, informal and semi-formal mediums at the design phase of DBLcH projects.

- Poor supervision is the inability of the contractor onsite supervisors to plan and direct site activities, as well as communicate adequately with site workers. This can result in waste increasing amount and cost of rework. This factor is identified to have significant influence on poor cost performances of DBLcH projects and contribute to all the seven areas of waste on the project. Whereas Alwi et al., (2002) and Akinde, (2012) did not rate it as significant, in a more recent study by Adewuyi and Odesola, (2015), it was identified significant. This could result from the contextual and contemporary changes in practice. Therefore can be viewed as an emerging finding contextual to DBLcH projects in Imo state Nigeria. To mitigate the effects of poor supervision on poor cost performance, engaging the right professionals as site supervisors is very important. Also upgrade training on contemporary skills for effective site supervisions such be encouraged by the contractor. This will assist in mitigating poor site supervision.
- Design changes is defined as variations or any change to the scope of the work as defined by the contract documents following the creation of legal relations between the principal and contractor (Choy & Sidwell 1991 cited in Alwi et al., 2002). This waste factor is also prioritized as a significant waste factor that could lead to loss of time, demolitions and other actions that leads to cost increase on the DBLcH projects. For example waiting for variation orders could lead to delay which may have cost implications. Also, if a structure has already been constructed, a change in design may result in demolition. This finding is seen to corroborate previous findings by Ekanayake and Ofori (2000), Muzhewi et al., (2012) and Akinde, (2012) who affirm that this waste factor is a very significant source of construction waste with high cost implications. As a result, effective collaboration among project team during design stage to grasp all necessary information needed for effective design is essential. During construction, a design change control evaluation approach should be established. These will help mitigate the barrier of Design changes.
- Inappropriate material storage facilities expose materials to possible damage from inclement weather conditions or from other site activities resulting in material waste amongst others. This finding corroborates previous works by Muhwezi et al.,(2012) and Enshassi, (1996) who also identified this waste factor as one of the major waste factors facing building projects in the Gaza Strip and Uganda respectively.

Therefore there is need for making appropriate site planning and provision for material storage and relevant training for handling sites facilities by provided for the site storage staff provided by the contractor. This will help mitigate the barrier of inappropriate material storage facilities on site.

- **Insufficient information for and during construction:** This could have an adverse effect on the level of work done on site. It would slow down project completion and lead to extra cost. Unclear Information makes it difficult for the contractor to develop well detailed work breakdown structure which impacts adversely on work process. According to Tipili et al., (2014) this factor ranked second most significant factor affecting the level of work done on project sites in Nigeria. Therefore, adequate information should be provided in well detailed contract documents as well as when requested during construction in a timely and effective manner. This will serve as a mitigating measure.

## **5. CONCLUSION AND RECOMMENDATION**

Waste has been identified as a contributing factor to poor cost performances challenging the effective supply of LcH in Nigeria and particularly in Imo state. The occurrences of waste have been attributed to actions within the project delivery process. The aim of this paper is to identify the waste factors influencing DBLcH project cost performances in Imo state Nigeria. Literature revealed several waste factors related to both design and construction that generate waste on building and housing projects. The findings from the literature provided a platform for the development of the questionnaire. The results from the analysis of questionnaire survey obtained from the project teams on DBLcH projects operating in Imo State Nigeria revealed 31 waste factors influencing poor DBLcH project cost performances. 21 waste factors were construction related, while 10 were design related.

Findings reveal that Five (5Nr) prioritized waste factors with very high significance influence on DBLcH project cost performances. These include, insufficient design information needed for construction, poor communication and coordination of the design team members, design changes, poor site supervision and inappropriate material storage facilities.

Based on these findings, it is possible to deduce that the prioritized five waste factors possess high significant influence on poor cost performances of DBLcH project in Imo state Nigeria. Therefore are problem areas which require very important attention of the project team towards eliminating waste and improving delivery cost performance of DBLcH projects in the state. It is recommended that the project team adopt the mitigation measures proffered in this paper towards improved cost performances.

The findings from this paper supports work conducted by previous researchers that there waste factors affect the performance of construction projects. It also contributes to the body of existing knowledge of waste factor identification in Nigeria particularly beneficial to the project team. This is because the findings are expected to increase their awareness on the significant factors influencing poor cost performances of DBLcH projects and how the factors can be mitigated based on the recommended measures proffered towards improved project cost performances in Imo state Nigeria.

Finally, this paper has made some significant contributions by identifying waste factors from a generic view point and contextualizing such in DBLcH project delivery in Imo state Nigeria. However, the study findings are limited only to DBLcH project in the LcH sector in Imo state. Therefore, further studies across LcH projects delivered through other procurement strategies are encouraged to identify waste factors that could be influencing their cost performances. This will facilitate exhaustive findings on waste factor identification towards improve project cost performances in the LcH sector of Imo state.

## 6. REFERENCES

- Adinyira, E., Botchway, E., & Kwofie, T. E. (2012). Determining critical project success criteria for public housing building projects (PHBPS) in Ghana. *Engineering Management Research*, 1. (2):122.
- Adewuyi, T. O., & Odesola, I. A. (2015). Factors affecting Material Waste on Construction Sites in Nigeria. *Journal of Engineering and Technology (JET)*, 6. (1): 82-99.
- Adewuyi, T. O. & Otali, M., (2013) Evaluation of Causes of Construction Material Waste - Case of Rivers State, Nigeria. *J, Ethiopian Studies, Env. Mgt.*, 6. (6):746-753.
- Agbola, T. and Alabi, M.: Sustainable Housing delivery: lesson from International Experience. A paper presented at the National Workshop on Sustainable Housing Delivery in Nigeria: Challenges for Public/ Partnership. Sheraton Hotel, Abuja. July 31 - August 1, 2000 (2000).
- Akdeniz, C., (2014). *Lean Principles Explained*. Bodendorf: Best Business Books.
- Akinde, S. B., (2012). *Lean Implementation towards Effective Low cost Housing Design and Construction Delivery in Nigeria*. (MSc Diss). Built Env. Univ. of Salford.

- Alwi, S., Hampson, K. & Mohamed, S. (2002). Waste in the Indonesian Construction Projects. Proceeding of CIB W107 1st International Conference: Creating a Sustainable Construction Industry in Developing Countries, 11 to 13 November, Stellenbosch, South Africa, 305-315.
- Amade, B., Ubani, E. C., Omajeh, E. O. M., Anita, U., & Njoku, P. (2015). "Critical Success Factors for Public Sector Construction Project Delivery: A Case of Owerri, Imo State", *International Journal of Research in Management, Science and Technology*, . 3. (1): 11-21
- Ambrose, P. J. (1991). The housing provision chain as a comparative analytical framework. *Scandinavian Housing and Planning Research*, 8.(2): 91–104.
- Anyanwu, J.C., 1997. The structure of the Nigerian economy (1960 - 1997). Onitsha: Joanee Educational Publishers Ltd
- Assaf, S. A., Bubshaitr, A. A., & Al-Muwasheer, F. (2010). Factors affecting affordable housing cost in Saudi Arabia. *International Journal of Housing Markets and Analysis*, 3. (4): 290-307.
- Aziz, R. F., & Hafez, S. M., (2013). Applying Lean Thinking in Construction and Performance Improvement. *Alexandria Engr. Journal*, 52.(4):679–695.
- Babatunde, S.O., Opawole, A. & Ujaddugbe, I. C., (2010). An Appraisal of Project Methods in the Nigerian Construction Industry. *Civil Engr. Dimen.*, 72.(1): 1-7
- Bakhtyar, B., Zaharim, A., Sopian, K., & Moghimi, S. (2013). Housing for Poor People: A Review on Low Cost Housing Process in Malaysia. *WSEAS transactions on environment and development*, 9(2): 126-136.
- Bertelsen, S. (2004). Lean Construction: Where are we and how to proceed. *Lean Construction Journal*, 1(1): 46-69.
- Chan, A.P.C. (2000). Evaluation of enhanced design and build system – a case study of a hospital project. *Construction Management and Economics* 18. (7):863 - 871.
- Creswell, J.W., (2014). *A Concise Introduction to Mixed Methods Research*. California: SAGE Publications, Inc.
- Daniel, W.H., (2006). *Construction Management*. 3<sup>rd</sup> Edition. Hoboken: John Wiley & Sons Inc.

- Dania, A.A., Kehinde, J.O., & Bala, K. (2007). A Study of Construction Material Waste Management Practices by Construction Firms in Nigeria. Proceedings of the 3rd Scottish Conference for Postgraduate Researchers of the Built and Natural Environment, Glasgow, 121-129.
- Davis, S. (1997). *The architecture of affordable housing*: California: Univ of California Press.
- Duru, P. N. & Anyanwu, S, (2014).The influence of Owerri urban development on housing in Irete, Owerri in Imo state, Nigeria. International Journal of Research In Social Sciences, 4.(2):71-75.
- Ekanayake, L. L. & Ofori, G., (2000). Construction Material Waste Source Evaluation. Proceedings of the 2nd Southern African Conference on Sustainable Development in the Built Environment, Pretoria, South Africa, 1-6.
- Enshassi, A., (1996). Materials control and waste on building sites. Building Research and Information, 24 (1): 31–34.
- Fadairo, G., & Olotuah, A. (2013). Low-Cost Housing for the Urban Poor in Akure , Nigeria : Materials and Techniques of Construction. *Journal of Environment and Earth Science*, 3. (9): 135–143
- Federal Ministry of Land Housing and Urban Development (FMLHUD), (2012). National Housing Policy Document.
- Fordnam, S. F., Gardner,J., Macmillan, A., Muldoon, C., &. Taylor, G., (1998). *Housing need and the need for housing*, Ashgate, Aldershot, Hants
- Formoso C. T., Isatto E. L., & Hirota E. H., (1999). Method for Waste Control in the Building Industry. In: Tommelein, I ., *Proceedings IGLC- 7*. 26-28 July 1999, Berkeley, IGLC.
- Gemade, T., (2012). Role of Federal Housing Authority in Nigeria Real Estate. In: NIIF, 2nd Nigeria international investment forum 2012 business roundtable: *Housing and construction*. 29-30<sup>th</sup>, March, 2012. Lagos.
- Hale, D. R., Shrestha, P. P., Gibson Jr, G. E. & Migliaccio, G. C., (2009). Empirical comparison of design/build and design/bid/build project delivery methods. *Journal of Construction Engineering and Management*, 135.(7): 579-587.
- Hecht, B. L. (2006). *Developing affordable housing: a practical guide for nonprofit organizations* (Vol. 221). John Wiley & Sons.



- Hanna, A.S., Wodalski, M.. & Whited, G.(2010). Applying lean techniques in delivery of transportation infrastructure projects. In: Proceedings of the 18th Annual Conference of the International Conference of Lean Construction (IGLC-18), Haifa, Israel, 2010.
- Hwang, B. G., & Lim, E. S. J. (2012). Critical success factors for key project players and objectives: case study of Singapore. *Journal of Construction Engineering and Mgt.*, 139.(2):204-215.
- Idiake, J.E., Shittu, A.A., Anunobi, I.A & Akanmu, W.P., (2015). A comparative analysis of traditional and design & build methods of procurement in the Nigerian Construction Industry. *International J. of Constr. Engr. and Mgt.*, 4.(1): 1-12
- Jingchun, L. (2011). *The Development of Affordable Housing A case Study in Guangzhou, China*.MSc. Disser. KTH, School of Architecture and the Built Environment (ABE), Royal Institute of Technology, Sweden
- Josephson, P.E. & Saukkuriipi, L. (2007). Waste in Construction Projects Call For a New Approach.". Centre for Management of The Built Environment, Building Economics and Management, Chalmers University of Technology Goteborg ([http://www.cmb-chalmers.se/publikationer/waste\\_construction.pdf](http://www.cmb-chalmers.se/publikationer/waste_construction.pdf) accessed 10/11/2014).
- Koskela, L., (1992). *Application of the New Production Philosophy to Construction"* Technical Report No. 72, Centre for Integrated Facility Engineering. Department of Civil Engineering. Stanford University. Finland.
- Kwofie, T. E., Fugar, F., Adinyira, E., & Ahadzie, D. K. (2014). Identification and Classification of the Unique Features of Mass Housing Projects. *Journal of Construction Engineering*, 2014,. 0) 1-11.
- Lean Construction Institute UK., 2015. *What is Lean Construction*. (Online) Available at: <http://leanconstruction.org.uk/what-is-lean/>accessed01/05/2015
- Leong, S.M and Tilley, P., (2008). A Lean Way to Performance Measurement: Reducing Waste by Measuring “NEXT” Customer Needs. In: Tzortzopoulos,P. & Kagioglou, M., Proceedings of the IGLC-16, *Safety Quality and the Environment*, 16<sup>th</sup>- 18<sup>th</sup> July, 2008, Manchester, IGLC.
- Liker, J., (2004). *The Toyota Way*. New York: McGraw-Hill.

- Machete, S M (1997). Waste management in construction sites of emerging contractors in South Africa. In: Stephenson, P (Ed.), 13th Annual ARCOM Conference, 15-17 September 1997, King's College, Cambridge. Association of Researchers in Construction Management,
- Makinde, O. O., (2014). Housing Delivery System, Need and Demand. *Environment Development and Sustainability*, 16.(1): 49-69.
- Makinde, O. O. (2014). Housing delivery system, need and demand. *Environment, Development and Sustainability*, 16. (1): 49-69.
- Masterman, J.W.E., (2002). *Introduction to Building Procurement Systems*. 2nd Edition. London: Spon Press
- McNelis, S. (2014). *Making Progress in Housing: A Framework for Collaborative Research*: Newyork, Routledge.
- Moore, D.R., & Dainty, A.R.J., (2001). Intra-team boundaries as inhibitors of performance improvement in UK design and build projects: a call for change. *Construction Management and Economics* 19.(6): 559 – 562.
- Mostafa, A., Wong, F. K. W., & Hui, E. C. M. (2006). Relationship between Housing Affordability and Economic Development in Mainland China—Case of Shanghai. *Journal of Urban Planning and Development*, 132.(1):62–70.
- Muhwezi, L., Chamuriho, L. M., & Lema, N. M. (2012). An investigation into Materials Wastes on Building Construction Projects in Kampala-Uganda. *Scholarly Journal of Engineering Research*, 1.(1): 11–18.
- Nagapan, S., Rahman, I. A., Asmi, A., Hameed, A., & Zin, R. M., (2012). Identifying Causes of Construction Waste - Case of Central Region of Peninsula Malaysia. *International J. of Integrated Engr.*, 4.(2): 22–28.
- Obi, L.I. and Arif, M. (2015). A Case for Target Value Design Towards Effective Low-Cost Housing Project Cost Management and Performance South-East Zone Nigeria, In: Egbu, C, *proceedings of CIB International Conference Going north for sustainability*, London south Bank University London, 23<sup>th</sup>-25<sup>th</sup> November, London: IBEA Publications Ltd.
- Ogbu, C. P., & Adindu, C. C. (2012). Project Management approach to public low income housing. *Journal of Research in National Development*, 10.(2): 142–153.

- Okoroafor, P. (2007), "Critical issues in the development of viable housing finance industry in Nigeria", paper presented at 2nd Emerging Urban African International Conference and Exhibition on Housing Finance, 17<sup>th</sup>-19<sup>th</sup>, October, Nigeria.
- Oladapo, M. (2001). A framework for cost management of low cost housing. In *International conference on Spatial Information for sustainable Development, Nairobi Kenya 2nd-5th october 2001*.
- Oladinrin, T.O., Olatunji, S.O & Hamza, T. B., (2013). Effect of selected procurement systems on building project performance in Nigeria. *International Journal of Sustainable Construction Engineering & Technology*, 4. (1): 48-62.
- Olaniran, H.F., (2015). On the role of communication in construction projects in Nigeria. *International journal of scientific & technology research*, 4. (7): 129-131.
- Olotuah, A. O. & Taiwo, A. A. (2013). Housing the urban poor in Nigeria through low-cost housing schemes. *International Journal of Physical and Human Geography*, 1(3), 1-8.
- Osmani, M., Glass, J., & Price, A. D. F., (2008). Architects' perspectives on construction waste reduction by design. *J of Waste Managt*, 28.(7): 1147-1158.
- Ozurumba, B. A. (2011). Urban Housing Financing in the South-Eastern States of Nigeria: Problems and Prospects. *Journal of Sustainable Development in Africa*, 13.(8): 268--282
- Polat, G., & Ballard, G., 2004. Waste in Turkish Construction: Need for Lean Construction Techniques. In: *Proceeding of 12th Annual Conference of the International Group for Lean Construction*. Elsinore, Denmark: IGLC-12.
- Rahman, H. A., Wang, C., & Lim, I. Y. W. (2012). Waste Processing Framework For Non-Value-Adding Activities Using Lean Construction. *Journal of Frontiers in Construction Engineering*, 1(1): 8-13.
- Sacks, R., Koskela, L., Dave, B. A. & Owen, R., (2010). Interaction of Lean and Building Information Modelling in Construction. *J. of Constr. Engr. and Mgt.*, 136.(9): 968-980.
- Shafik, M., & Martin, P. (2006, September). The impact of procurement methods on the Scottish house building industry. In *22nd Annual ARCOM Conference* (Vol. 4, No. 6).

- Sibiya M., Aigbavboa C.O., & Thwala W.D (2014). A Theoretical Harmonization of the Factors Affecting the Performance of Construction Projects. Paper presented in 6th International Conference on Humanities, Geography and Economics (ICHGE'2014) Nov. 27-28, 2014 Cape Town (South Africa)
- Sibiya M., Aigbavboa C.O., & Thwala W.D (2014). An Assessment of Performance of Construction Projects on South Africa. Available at <http://www.ppml.url.tw/EPPM/conferences/2015/download/An%20Assessment%20of%20Performance%20of%20Construction%20Projects%20on%20South%20Africa.pdf> accessed 10/1/2016.
- Tersine, R.J., (2004). The primary drivers for continuous improvement: The reduction of the triad of waste. *Journal of Managerial Issues* , 16. (1):15-29.
- Tourangeau, R., Rips, L. J., & Rasinski, K. A., (2000). *The Psychology of Survey Response*. Cambridge: Cambridge University Press.
- Tipli, L.G, Ojeba, P.O. & Ilyasu, M.S. (2014). Evaluating the effects of communication in construction project delivery in Nigeria. *Global Journal of Environmental Science and Technology*, 2. (5): 048-054.
- Tiwari, P. (2001). Housing and development objectives in India. *Habitat international*, 25.(2): 229-253.
- Ubani E.C., Okorochoa, K.A. & Emeribe, S.C., (2013). Analysis of factors influencing time and cost overruns on construction projects in South Eastern Nigeria, *International Journal of Management Sciences and Business Research*, 2. (2): 73-84.
- Ukiwo, U., & Chukwuma, I. (2012). Governance And Insecurity In South East Nigeria. Imo: Cleen Foundation.
- United Nations Human Settlements Program (Un- Habitat)., (2011). *Affordable Land and Housing in Africa*. Nairobi, UNON, Publishing Services.
- Wahab, A. B. & Lawal, A. F., (2011). An Evaluation of Waste Control Measures in Construction Industry in Nigeria. *African J. of Env. Science and Technology*, 5.(3): 246-254.
- Withana-Withana-Gamage, I. S. (2011). *A waste minimisation framework for the procurement of design and build construction projects*. Doctoral dissertation, Loughborough's University United Kingdom